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**United States Patent** [19]**Blackman et al.**[11] **Patent Number:** **5,644,956**[45] **Date of Patent:** **Jul. 8, 1997**[54] **ROTARY DRILL BIT WITH IMPROVED CUTTER AND METHOD OF MANUFACTURING SAME**4,630,692 12/1986 Ecer ..... 175/374 X  
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(List continued on next page.)

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[51] Int. Cl.<sup>6</sup> ..... **B21K 5/02; F21B 10/08**[52] U.S. Cl. .... **76/108.2; 175/371; 175/432;**  
175/434[58] **Field of Search** ..... 76/108.1, 108.2;  
175/371-374, 432, 434[56] **References Cited****U.S. PATENT DOCUMENTS**

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[57]

**ABSTRACT**

A rotary cone drill bit for forming a borehole having a body with an underside and an upper end portion adapted for connection to a drill string. The drill bit rotates around a central axis of the body. A number of angularly-spaced arms are integrally formed with the body and depend therefrom. Each arm has an inside surface with a spindle connected thereto and an outer shirttail surface. Each spindle projects generally downwardly and inwardly with respect to its associated arm, has a generally cylindrical upper end portion connected to the associated inside surface, and has an inner sealing surface on the upper end portion. A number of rotary cone cutters equal to the number of arms are each mounted on respective spindles. Each of the cutters includes an internal generally cylindrical wall defining a cavity for receiving the respective spindle, a gap with a generally cylindrical portion defined between the spindle and cavity wall, an outer sealing surface in the cavity wall concentric with the inner sealing surface, and a seal element spanning the gap and sealing between the inner and outer sealing surfaces. The gap includes an opening contiguous with and directed outwardly from the shirttail surface. A shirttail tip may be included to form a generally planar second portion of the gap defined between the inside surface and the cutter, the second portion substantially perpendicular to the first portion. The rotary cone cutters are preferably composites formed from different types of material.

**19 Claims, 6 Drawing Sheets**